A FINLESS TRAINING PROJECTILE WITH IMPROVED FLIGHT STABILITY OVER AN EXTENDED RANGE

DESCRIPTION

FEDERAL RESEARCH STATEMENT

[Para 1] The inventions described herein may be manufactured, used and licensed by or for the U.S. Government for U.S. Government purposes.

BACKGROUND OF THE INVENTION

[Para 2] FIELD OF THE INVENTION

[Para 3] The present invention generally relates to training munitions for training military personnel. In particular, the present invention relates to a finless training projectile that develops spin in flight from radially angled slots in a slotted tail piece.

[Para 4] The military has many different types of projectiles of tank and artillery rounds. In addition, new projectiles of tank and artillery rounds are continually being developed. For each operating projectile, an identically shaped training cartridge is required for use in training personnel who will use the real or tactical projectile.

[Para 5] The performance of training projectiles should correspond to the matching real or tactical projectile as closely as possible. Conventional training rounds utilize folding or fixed fin training round designs to achieve a ballistic match to tactical (service) projectiles. Although this technology has proven to be useful, it would be desirable to present additional improvements. What is needed is a training projectile with improved static margin and reduced

sensitivity to center of pressure shift that can be fired from smooth bore and rifled cannons of various calibers, including 120 mm and 105 mm. The need for such a training round has heretofore remained unsatisfied.

SUMMARY OF THE INVENTION

[Para 6] A finless, cone-nosed, ogival-nosed, or combination ogive-cone nosed training projectile is statically stable, yet has adequate spin rate to compensate for aerodynamic or mass asymmetries. In addition, the finless, cone-nosed training projectile can be fired from smooth bore or rifled cannons of various calibers, including 120 mm and 105 mm. Spin torque and stability augmentation are provided by a radially angled slotted tail flange attached to the rear of the finless, nose-coned projectile. Design of the slotted tail flange can be tailored to provide a ballistic match to tactical projectiles.

[Para 7] The finless training projectile provides high performance at low cost for use in training exercises. Although conventional spike-nose training projectiles have proven to be satisfactory for their intended purpose, the present finless training projectile provides a higher stability throughout its flight regime.

[Para 8] More specifically, the finless training projectile maintains a higher static margin than the conventional spike-nose training projectile due to the following two improvements. The first being that the center of gravity for the flight projectile has been moved further forward. The second is that the center of pressure remains in a constant rearward position, throughout the Mach number range encountered during flight. This combination of physical features provides greater flight stability for enhanced target accuracy.

[Para 9] Propellant for training projectiles is provided in a cartridge attached to a base of the training cartridge. Any fins or other flight stabilizing features

on the base of training projectiles intrude into the cartridge. The finless, cone-nosed training projectile requires relatively little space in the cartridge, freeing up space in the cartridge for propellant. Consequently, a less energetic, more economical propellant can be used, further reducing training costs and improving performance.

BRIEF DESCRIPTION OF THE DRAWINGS

[Para 10] The various features of the present invention and the manner of attaining them will be described in greater detail with reference to the following description, claims, and drawings, wherein reference numerals are reused, where appropriate, to indicate a correspondence between the referenced items, and wherein:

[Para 11] FIG. 1 is a cross-sectional view of an exemplary training cartridge in which a finless, training projectile of the present invention can be used;

[Para 12] FIG. 2 is a side view of the exemplary finless training projectile of FIG. 1;

[Para 13] FIG. 3 is a side view of an ogive-shaped nose for use in the training projectile of FIG. 1;

[Para 14] FIG. 4 is a side view of a cone-cylinder shaped nose for use in the training projectile of FIG. 1; and

[Para 15] FIG. 5 is a side view of a combination cone-ogive shaped nose for use in the training projectile of FIG. 1.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[Para 16] FIG. 1 is a cross-sectional diagram of a training cartridge 100 comprising a finless, ogival-nosed training projectile 10 (also referenced herein as projectile 10) according to the present invention. The training cartridge 100 comprises a canister 15 and a propellant 20. The projectile 10 comprises a body 25 and a tail 30.

[Para 17] FIG. 2 is a diagram of projectile 10. Reference is made to U. S. Patent No. 005,238,130, which is incorporated herein in its entirety. A stabilizer 205 of the projectile 10 is shown attached to the rearwardmost (tail) end of the projectile 10. Projectile 10 may be, for example a tank round for a 120 mm smooth bore system. Stabilizer 205 ensures that the projectile spins when fired from such a smooth bore or non-rifled system. Projectile 10 possesses a nose forwardmost (front) portion 210 and a rearward or aft cylindrical portion 215 having stabilizer 205 attached thereto. The diameter of cylindrical portion 215 is slightly smaller than the inside diameter of the bore of tube from which the projectile is fired. Obturator 220, fastened about the cylindrical portion of the projectile 10 provides a friction fit between the bore of the cannon and projectile 10 to prevent forward thrust gasses from escaping from the bore prior to the escape of the projectile 10 when fired. The projectile 10 and the stabilizer 205 have a common longitudinal axis 225.

[Para 18] The stabilizer 205 as shown is cylindrical having two distinct diameters and a single longitudinal axis 225. For simplicity, stabilizer 205 can be characterized by two integrally connected, adjacent and coaxial cylindrical segments 230 and 235. Segment or flange 235 has a diameter slightly smaller than the inner diameter of the bore of the cannon from which the projectile is fired. That is, the diameter of segment 235 is equal to, or substantially equal to, the diameter of the largest cylindrical portion of the projectile 10. For instance, if the projectile 10 is for a 120 mm smooth bore system, the largest

cylindrical portion of projectile 10 (other than obturator 220) has a diameter of approximately 119.3 mm, which is substantially the dimension of the diameter of cylindrical segment 235.

[Para 19] Unless stated otherwise, any dimension recited herein is a dimension for a 120 mm smooth bore system.

[Para 20] Segment 235 has an axial length 240 of approximately 10.1 mm, and a periphery of segment 32 has equally spaced, circumferentially positioned, angled slots 245 or air flow-through channels, which traverse the length of segment 235. The angled slots 245 are defined by substantially parallel side walls separated by a surface which is either planar or arcuate shaped. The slot width 250, or more accurately the perpendicular distance between slot walls, is approximately 18.1 mm. As shown, side walls of the slots are negatively sloped, relative to the longitudinal axis 225 of segments 230 and 235, creating angled slots 245.

[Para 21] The stabilizer for a 120 mm caliber projectile has six circumferentially, equally spaced apart angled slots 245 which are positioned equiangularly, i.e., every sixty degrees about the periphery of segment 235 with slot walls being angled at thirty degrees relative to longitudinal axis 225.

[Para 22] The number of angled slots 245 is not critical, as long as the number is greater than one and the slots are positioned symmetrically about the periphery of segment 235; nor is the angle of the slot walls, relative to the longitudinal axis 225, critical as long as the angle is between zero and ninety degrees. Preferably, the angle is between fifteen and seventy-five degrees and most preferably, for the 120 mm caliber system, the angle is thirty degrees. It has been determined that the number of slots on the stabilizer is directly proportional to the time required for a projectile to reach a steady state, i.e., a

constant rate of spin, and the angle of the walls determines the spin rate. The projectile 10 shown in FIG. 2 having stabilizer 205 attached thereto with six equally spaced apart slots 245 and slot walls angled at thirty degrees, relative to the longitudinal axis 225 of the segments 230 and 235, and traveling faster than the speed of sound, will spin at a rate of twenty-five revolutions per second. The steady state is reached in seconds.

[Para 23] As illustrated by FIG. 2, the stabilizer 205 can be connected to the rear end of an ogive-nosed shaped projectile and may be made in dimensions to fit a projectile of any smooth bore system. In operation, as a projectile exits the bore of the non-rifled cannon, above the speed of sound, air passes over cylindrical segment 230 and is directed through angled slots 245 on the periphery of cylindrical segment 235. As shown in FIG. 2, the walls of slots 245 have a negative slope and as air passes through slots 245 the projectile 10 spins in a clockwise direction (when viewed from the rear). Reversing the slope of the walls of slots 245 will force the projectile to rotate in the counter clockwise direction.

[Para 24] Adjacent, integrally connected, and coaxial to cylindrical section or flange 235 is cylindrical section 230. Cylindrical section 230 has a diameter smaller than the diameter of cylindrical section 235 and an axial length 247 longer than the axial length 240 of cylindrical section 235. The diameter of cylindrical section 230 is approximately 102.6 mm, and the axial length 247 is approximately 43.6 mm. The difference in diameters between cylindrical segments 235 and 240 defines the depth of slots 245.

[Para 25] The device reaches a steady state or a constant spin rate in a matter of seconds, and this spin rate is accomplished by reducing the conventional length of a prior art projectile without the need for fins extending beyond the diameter of the projectile. The device as described may be machined from a

solid piece of aluminum or other light and malleable metal. Slots may be cut into the metal using a router bit.

[Para 26] A center of gravity (CG) 255 is indicated for projectile 10 on FIG. 2. A center of pressure 260 is further indicated for projectile 10. The ogival shaped nose 210 provides increased mass to move the center of gravity 255 to a forward position on projectile 10. The ogival shaped nose 210 further allows the center of pressure to remain in a constant position during flight. Consequently, a distance D 265 between the center of gravity 255 and the center of pressure 260 remains constant during flight, providing improved flight stability over an extended range of flight.

[Para 27] The ogival shaped nose 210 is further illustrated in FIG. 3. In one embodiment, the projectile 10 comprises a cone-shaped nose 405 as illustrated by FIG. 4. In a further embodiment, the projectile 10 comprises a combination ogival/conical nose 505 as illustrated by FIG. 5. the combination ogival/conical nose 505 comprises a conical portion 510 and an ogival portion 515. The shape of the nose of projectile 10 is selected to position the center of gravity 255 of the projectile 10.

[Para 28] It is to be understood that the specific embodiments of the invention that have been described are merely illustrative of certain applications of the principle of the present invention. Numerous modifications may be made to a finless, cone-nosed training projectile described herein without departing from the spirit and scope of the present invention.